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Eddy covariance measurements of net C exchange in the CAM bioenergy crop, *Agave tequiliana*

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Bioenergy crop cultivation may focus more on low grade and marginal lands in order to avoid competition with food production for land and water resources. However, in many regions, this would require improvements in plant water-use efficiency that are beyond the physiological capacity of most C_3 and C_4 bioenergy crop candidates. Crassulacean acid metabolism (CAM) plants, such as *Agave tequiliana*, can combine high above-ground productivity with as little as 20% of the water demand of C_3 and C_4 crops. This is achieved through temporal separation of carboxylase activities, with stomata opening at night to allow gas exchange and minimise transpirational losses.

Previous studies have employed 'bottom-up' methodologies to investigate carbon (C) accumulation and productivity in *Agave*, by scaling leaf-level gas exchange and titratable acidity (TA) with leaf area index or maximum productivity. We used the eddy covariance (EC) technique to quantify ecosystem-scale gas exchange over an *Agave* plantation in Mexico ('top-down' approach). Measurements were made over 252 days, including the transition from wet to dry periods. Results were cross-validated against diel changes in titratable acidity, leaf-unfurling rates, energy exchange fluxes and reported biomass yields.

Net ecosystem exchange of CO_2 displayed a CAM rhythm that alternated from a net C sink at night to a net C source during the day and partitioned canopy fluxes (gross C assimilation, $F_{A,EC}$) showed a characteristic four-phase CO_2 exchange pattern. The projected ecosystem C balance indicated that the site was a net sink of -333 $\pm$ 24 g C m^{-2} y^{-1}, comprising cumulative soil respiration of 692 $\pm$ 7 g C m^{-2} y^{-1} and $F_{A,EC}$ of -1025 $\pm$ 25 g C m^{-2} y^{-1}. EC-estimated biomass yield was 20.1 Mg ha^{-1} y^{-1}. Average integrated daily $F_{A,EC}$ was -234 $\pm$ 5 mmol CO_2 m^{-2} d^{-1} and persisted almost unchanged after 70 days of drought conditions. Our results suggest that the carbon acquisition strategy of drought avoidance employed by *Agave* and other CAM plants could offer significant yield advantages over conventional arid and semi-arid C_3 and C_4 bioenergy crops. Furthermore, their capacity for high productivity on marginal land and drought resilience suggest that CAM plants could play an important role in addressing conflicting land and water resource allocation issues.